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ON STAINED GLASS WINDOWS.

LEGEND OF SAINT ROMAIN, IN STAINED GLASS.

AMONG the splendid monuments of Gothic architecture, constituting, as they do, the pride and the glory of the middle ages, we find all those arts which are subsidiary to the one great object of erecting a noble edifice in a state of great perfection. Carving of wood, or cutting of metal into ecclesiastical ornaments; inlaying with gold, silver, and precious stones; sculpture; painting; organ-building; the composition of church-music; and the staining of glass; these were a few of the means by which religious communities contributed to the imposing splendour of cathedrals and churches, and of the offices performed therein. We will not stop to inquire whether that great boon to humanity—the Reformation,—was so far an exception to all other human blessings, as to be altogether unalloyed with some circumstances which may excite regret: all we wish to observe on this point is, that since the Reformation, Gothic architecture and its subsidiary arts have greatly declined: it has even been asserted, that the art of glass-staining fell into such general disuse that at the beginning of the last century it was considered as an obsolete and irrecoverable art. This assertion has been made over and over again; but, availing ourselves of undeniable sources of information, we shall find that there are no good grounds for the charge; since at the very time when the art was considered as lost, some of the finest stained glass windows were painted, from 1616 to 1700; and others by Jervis Forrest, up to 1785.

In proceeding to notice these beautiful productions which

> Shed their many-coloured lights
> Through the rich robes of eremites and saints,

we propose to divide the subject into three parts. We shall, *first*, offer a brief account of the history of the art; *secondly*, an account of the processes employed by the glass-stainer; and, *thirdly*, a notice of some of the most celebrated windows which adorn the venerable buildings of our own country, the pre-

servation of whose pure faith is the object of every rightly-constituted mind.

Among numerous contradictory statements respecting the manufactory of stained glass among the moderns, we cannot but refer to the information afforded by an examination of the literary and architectural remains of antiquity. We find that the Romans excelled in the art of fabricating gems and artificial stones, the transparency, the lustre, and the colour of which were greatly admired. They seem to have had greater difficulty in producing colourless glass; for we read, that the emperor Nero paid 6000 sestertia, or about 50,000*l.* of our money for two small drinking-cups with handles, the chief excellence of which consisted in their being colourless. The glass in common use was of an inferior description; it was generally thick, of an opaque white, and often of a blueish colour. In the reign of Tiberius a company of glass-manufacturers established themselves in Rome, and dwelt in a street near the Porta Capena: but the articles manufactured at this place appear to have been few in number, and poor in quality. In the time of Tiberius a curious discovery is referred to, of an architect who had been banished from Rome, in consequence of having incurred the displeasure of the emperor; but having discovered a malleable or ductile glass, he thought to propitiate the emperor by an exhibition of his skill. The artist appeared before him, bearing a glass vessel which he dashed upon the ground without its being broken. The blow merely distorted the shape of the vessel, which the artist remedied by hammering it again into shape, as if it had been made of brass. The emperor, however, instead of rewarding the artist, ordered him to be put to death, remarking, that such a discovery would, if known, tend to make gold of no more value than common clay. This story is variously related, and, if true, proves that the artist made a discovery of which the world is yet ignorant; although an artisan in the time of Louis the Thirteenth is said to have presented the Cardinal Richelieu with a bust made of *ductile* glass; but the minister, with great simplicity, forbade the revelation of the processes by which it was made, fearing that its introduction would tend to injure the glass-manufactories of France.

The ancient Egyptians were doubtless well acquainted with the art of glass-making. Glass beads and other glass ornaments neatly made and beautifully coloured, are found among the ornaments of mummies, which are known to be more than three thousand years old. The Phœnicians were, at an early period, celebrated for the excellence of their glass, which at one time was sold in Rome for large sums. The cups and sepulchral urns which adorn many of our museums, prove a great skill in glass-blowing, and display a delicacy of workmanship not excelled by modern art. The celebrated Portland vase in the British Museum is composed of very deep blue glass, with figures of a delicate white enamel raised on it in relief. This splendid specimen of ancient art was found in the tomb of Alexander Severus, who died A. D. 235.

We find coloured glass beads and amulets among the Druidical remains of this country, whence it has been argued by some antiquaries, that the art of glass-making was known in Britain before the invasion of the Romans. This, however, is subject to great doubt, for these beads and amulets are of admirable workmanship, and beautifully coloured, so as to imitate gems and precious stones. The most probable theory of their introduction into Britain at this early period is, that the ancient Britons procured them from the Syrians, who visited the island in the way of trade, and bartered them in the same manner as we do at the present day with the South Sea islanders, who, in common with most rude nations, delight in toys and trinkets. However, it is quite clear that the ancient Britons were abundantly supplied with these glass ornaments, and that they connected them with their religious observances at a period long anterior to the Roman invasion, as they are found in barrows of a much older date. A large quantity of them have been found in the barrows which are so numerous on Salisbury Plain.

Druidical glass rings, too, have been found, which, according to popular superstition, have a curious origin: they are said to have been produced by "snakes joining their heads together and hissing, when a kind of bubble like a ring was formed round the head of them, which the others, continuing to hiss, blew on, till it came off at the tail, when it immediately hardened into a glass ring." A person finding one of these snake-stones was deemed fortunate and happy. They seem, however, to be nothing more than means employed by the Druids to deceive the vulgar: they are generally of a green colour, but some of them are blue, and a few are variegated with streaks of white, red, and blue.

Such, then, are a few notices of the art of staining glass chiefly with reference to the production of artificial gems and precious stones. It is very probable that the art of staining or painting on glass is coeval with the art of glass-making for domestic purposes. It is very difficult to make colourless transparent glass; the materials employed are generally such as will produce colour, and the idea doubtless occurred to the earliest makers that glass with a pure homogeneous stain might be more easily made than colourless glass, and would be more ornamental: but to produce glass upon which are traced figures of men, animals, foliage, and general ornaments, was a far more difficult undertaking. It bespeaks a time when great skill and knowledge in chemistry and art was attained. No wonder, then, that the first essays were rude both in design and execution. We find among the earliest attempts to produce pictures of coloured and transparent glass, certain specimens composed of pieces of glass clumsily joined together by a vein of lead run upon the back of the picture, precisely at the junction of pieces of variously-coloured glass, so arranged as to produce the desired figure of a man, &c.

At the time of this mode of manufacture, the glass pictures of the ancients were probably unknown. Modern research has offered to our notice some wonderful instances of ancient skill. Winckelmann speaks of pictures formed by means of delicate glass fibres of various hues, which being fitted and adjusted together with great nicety, were united by fusion into a solid mass.

About the ninth century, when so many of the splendid ecclesiastical edifices were erected on the continent, we find frequent mention of the art of glass-painting. But for a long time the painted windows used in cathedrals were merely painted on the surface; the art of staining the glass itself by fusion being unknown until the beginning of the fifteenth century. This great improvement is said to be due to a painter of Marseilles; but the French throw the date of the invention several centuries back, and, with their accustomed vanity, claim not only the invention, but most of the improvements in this beautiful and difficult art. However this may be, it is certain that the French have produced some admirable specimens of glass-painting. Our frontispiece represents a portion of a large window in the

church of St. Godard at Rouen. This is a production of the sixteenth century, and is a masterly performance, whether as regards the design of the artist, or the work of the glass-stainer. We shall presently speak of the legend which this window commemorates.

In our own country, up to the time of King John, stained or painted glass was imported from Italy. In the reign of Henry the Third, a few notices of the construction of painted windows occur. In the time of Henry the Fourth, we find the name of John Thornton, of Coventry, a glazier and glass-stainer, who was employed to paint the eastern window of York Cathedral. The terms of his engagement were as follows: four shillings per week of regular wages, because he was a "masterlye workeman." If he abided by his contract to finish the work in three years, he was to receive over and above the weekly allowance, for each year, one hundred shillings; and at the completion of the work, if the dean and chapter of York approved thereof, he was to receive the further sum of ten pounds.

From this period to the time of the Reformation, many excellent glass-stainers appeared in England. That great event tended to check the progress of art in this country, but did not, as is generally supposed, render the art of glass-staining obsolete. The following is a list of the most eminent English glass-stainers ranged alphabetically, with a slight notice of their principal works.

Bachler, a painter on glass of the last century.

Beckwith. To this skilful artist is due the magnificent window of Arundel Castle, representing King John granting the Magna Charta.

Collins, an eminent artist of our own time, who has executed some admirable works in some of the French cathedrals.

Eginton, F., in 1794, repaired the fine window representing the Last Judgment, in the chapel of Magdalen College, Oxford, and executed several noble windows in the same chapel. He also executed windows for All Souls' College and Windsor Castle. He died in 1805.

Forest, pupil and assistant of Jarvis.

Giles, Henry, painted the eastern window of the chapel of University College, Oxford, representing the Nativity. The gift of Dr. Radcliffe.

Godfrey, R. S., executed a splendid work at Paris in 1769, which is said to surpass the works of the old stainers.

Jarvis painted the altar-piece in St. George's Chapel, Windsor, after the design of West, representing the Resurrection.

Jervais, in 1777, painted the large western window of New College, Oxford, after the designs of Sir Joshua Reynolds.

Linge, in 1636, painted the windows in the chapel of Queen's College, Oxford, and in 1641 those of University College Chapel. Those in the chapels of Wadham and Baliol Colleges were also executed by him.

Marlow was also employed about the windows of All Souls'.

Olivier, Isaac, in 1700, at the age of eighty-four years, executed the window in Christ Church, Oxford, representing Peter delivered from Prison by an Angel. Professor Buckland says that the colours of this work are changed by time.

Pearson, in 1776, after the designs of Mortimer, painted the magnificent window of Brazen Nose College.

Peckitt, of York, from 1765 to 1774, was engaged on the windows of New College Chapel. The colours in these works are now greatly changed.

Picket, in 1762, executed a fine window for Lincoln Cathedral.

Price, William, at the beginning of the eighteenth century, executed several works for the colleges at Oxford. He was succeeded by his son.

Such, then, is a list of the principal English glass-stainers. A host of splendid windows executed by them, sufficiently attests that the art has been cultivated with success in this country, although many of the continental writers deny that the English ever did or could cope with continental artists. In a future article we propose to examine in detail a few of the finest specimens of stained glass windows due to English workmen. To illustrate the present brief sketch of the history of the art, we have chosen our frontispiece from a work of the old stainers, to express, as well as can be done in the absence of the splendid transparent colours of the original work, the masterly skill of the old artists. There are some fine windows in the churches of Rouen, illustrating many of the legends peculiar to the faith of the church of Rome, and although we by no means approve of the subjects which these windows are intended to illustrate, yet we may be allowed to speak of them merely as works of art in terms of praise.

The subject of the legend which these windows commemorate is a passage in the life of St. Romain, who filled the episcopal chair of the cathedral of Rouen. Many wonderful stories are related of this prelate. It is said that in his time a frightful winged dragon devastated the neighbourhood of Rouen, and indulged, after the approved fashion of such monsters, in sundry feasts on human beings, &c. St. Romain determined to rid the country of this scourge, and after many snares and traps had been set and laid in vain, he determined to go in person to the forest-haunt of the monster. He took with him two criminals, one of whom was sentenced to death, to assist him in the chivalric deed. As they drew near the spot, the condemned criminal fled at the sight of the dragon, (see frontispiece:) but the other criminal, taking the girdle of the holy man, approached the monster. At the sight of the girdle it became "as gentle as a lamb," submitted to be bound therewith, and was thus conducted to the prelate, who caused it to be taken into the market-place of Rouen and publicly burnt. Its ashes were then thrown into the river Seine.

Ignorance only could ever have dictated the sentiment that anything was made in vain—that ignorance which leads its victim to believe that he is the only object on which the good gifts of Providence should have been lavished, and, finding things in the universe which he can neither understand nor make use of, impiously to deem them useless, and made without a purpose. But he who considers the myriads of beings, besides those of his own race, which are nourished by the hand of Providence, and the thousand purposes to be worked out in the great laboratory of nature, of the very existence of which, much more their need and means of fulfilment, he is ignorant, will never be hasty to conclude of anything, that it exists "in vain." It were strange indeed, if the Father of creation should reveal all his purposes to one of his feeble creatures, and teach his deepest mysteries to him, to whom his own existence is an inexplicable mystery. Science never fails to teach him who pursues it in the love of it, more and more to mistrust himself; and the further onward he pursues its paths, the more insignificant does he feel himself to be, as he sees its interminable fields spreading wider before him, beyond the very borders of which he does not seem to have progressed.—?

What Pleasure it is to pay One's Debts!—I remember to have heard Sir Thomas Lyttleton make this observation. It seems to flow from a combination of circumstances, each of which is productive of pleasure. In the first place it removes that uneasiness which a true spirit feels from dependence and obligation. It affords pleasure to the creditor, and therefore gratifies our social affection. It promotes that future confidence, which is so very interesting to an honest mind: it opens a prospect of being readily supplied with what we want on future occasions: it leaves a consciousness of our own virtue: and it is a measure we know to be right, both in point of justice and of sound economy. Finally, it is the main support of simple reputation.—Shenstone.

ON WRITING MATERIALS.

No. IX.

ON SEALING WAX.

THE practice of employing seals on letters and other written documents, has, like most other customs of general adoption, undergone many changes and gradual improvements. The purposes for which they have been applied, the material of which they have been formed, the devices impressed upon them, and the mode of fixing them to the parchment or paper to which they are to be attached, have all been subject to many mutations,—a description of a few of which may not be without interest to the general reader.

In France, the custom in early times was, to seal instruments and other documents, instead of signing them; as appears from innumerable ancient charters which are not signed at all. The reason of this custom was, that in those days very few people were able to write; scarcely any one, indeed, could either read or write but clerks; and the custom continued till the times when learning made its way among them, although the reason for doing so had ceased to operate.

In earlier times than those of which we have just been speaking, however, the affixing of seals to written documents was a common practice. The material employed for this purpose by the Egyptians, Romans, and other ancient nations, was a kind of earth, known as *terra sigillaris*, or sealing earth. The Egyptian priests bound to the horns of the cattle, which were fit for sacrifice, a piece of paper, stuck upon some sealing earth, on which they made an impression with the sacred seal; and such cattle only could be offered up as victims. An allusion to the use of sealing earth is made by Lucian, in a passage where he speaks of a fortune-teller, who directed that those who came to consult him, should write down on a bit of paper the questions they wished to ask, to fold it up, and to seal it with clay or some similar substance.

One of the mythological tales of the ancients turns upon the employment of an earth as a material for seals. A Sybil received a promise from Apollo, that she should live as long as she did not see the earth of the island Erythrea, on which she lived. To avoid the impending liability of death, therefore, she quitted the place, and retired to Cumæ, where she became old and decrepit. But on one occasion she happened to receive a letter sealed with Erythrean earth, upon looking at which she instantly expired.

Leaving the realms of fiction, however, there is a curious circumstance related, by means of which Cicero was enabled to prove the authenticity of a document by the seal attached thereto. In a legal contest between two individuals, two contradictory documents were produced, each of which purported to have come from Asia; but Cicero proved that the one which he produced was the genuine document, from the circumstance that it was sealed with sealing earth, as was customary in Asia; whereas, the document produced by the opposing party was sealed with wax, a practice only adopted by the nations of the West, and therefore pointing out the document as surreptitious.

Earth, such as we have described, seems to have been employed for sealing by the emperors of the East; for we are told that at the second council of Nice, a certain person defended the worship of images, by saying, that no one believed that those who received written orders from the emperor, and venerated the seal, worshipped on that account the sealing earth which had been applied to the paper.

The employment of earth for these purposes was in after times superseded by that of flour paste, with which monarchs used frequently to seal their letters. There was also employed a composition called *maltha*, which appears to have consisted of pitch and wax, mixed in certain proportions. Before the time of William the Conqueror, the English did not seal with any substance in a soft state, but only made a golden cross on the parchment, and sometimes an impression on a piece of lead, which hung to the grant or other document by a silken thread, and was deemed a sufficient proof of the tenability of the grant, without either signing or witnesses.

Another substance was, however, gradually introduced as a material for seals, and soon usurped the place of most of those formerly in use. This was wax. Wax has the property of easily melting by the application of heat, and of again solidifying; and, therefore, presented a useful substitute for the earth formerly employed, which must necessarily have been liable to crumble to dust. Yellow wax was first employed, as being most readily obtained; and after a time white wax was also used. Then came various attempts, in the fourteenth century, to give to the wax fanciful colours of different kinds: sometimes green, at other times black was the prevailing colour. The attempts to produce blue wax were, at that period, and for a long time afterwards, unsuccessful; for when a vegetable blue-colouring substance was mixed with the wax, the resulting tint was always green; and the mineral bodies employed for the same purpose, subsided to the bottom when the wax was melted, instead of combining with it. This circumstance gave a very questionable value to a grant which the Emperor Charles the Fifth made to Dr. Stockamar, of Nuremburg, in 1524; which was, the privilege of using blue seals in wax.

Soft wax for sealing, such as we here allude to, is made in our own day in the following manner:—One pound of bees' wax, three ounces of turpentine, and one ounce of olive oil, are put into a proper vessel over the fire, and allowed to boil for some time, when the mixture will be well incorporated, and fit to be formed into rolls or cakes for use. To colour such soft wax, an ounce of any one of the colouring substances of which we shall presently speak, must be stirred in while boiling, till thoroughly incorporated with the wax. By pouring the melted soft wax into cold water, it is brought to the requisite consistency to be formed into the rolls or cakes. But before this is done, the wax is sometimes perfumed: this is effected by adding to every pound of wax, an ounce of gum benjamin, a scruple of oil of rhodium, ten grains of musk, five grains of civet, and five of ambergris. These various scents are rubbed up with the oil, and sprinkled on the wax while in a warm state.

We have still to speak of the real sealing wax of modern times; a substance which affords us one instance among many, of the misapplication of terms. No wax whatever is employed in this substance: indeed, if wax were employed, the substance would never assume, after being melted, the hard and brittle character which it presents to us.

There are many contradictory accounts of the invention of sealing wax: neither the date of its discovery, nor the name of the discoverer, being well agreed upon. Some have supposed that it was first prepared in the East, from the circumstance that the lac, which is its principal ingredient, is an eastern product. Beckmann says, that in the collection of curiosities in the university of Gottingen, are two sticks of sealing wax, which Professor Butner procured from Constantinople, under the name of *Turkey*

wax: they are angular, bent like a bow, are neither stamped or glazed, and are of a dark but pure red colour. There are in the same collection two other sticks which came from the East Indies, and which are straight, glazed, made somewhat thin at both ends, have no stamp, and are of a darker and dirtier red colour. All these four sticks seem to be lighter than those made at the present day, and do not appear to acquire so strong an electrical excitation by rubbing.

One account of the introduction of sealing wax into common use, is as follows:—Francis Rousseau, born near Auxerre, in France, travelled through Persia, Pegu, and other parts of the East, by which he acquired considerable knowledge of the manufacturing processes of the East. Having, while he lived at Paris as a merchant, during the latter years of the reign of Louis the Thirteenth, lost all his property by fire, he entered on the project of preparing sealing wax from gum lac, (as he had seen it prepared in India,) in order to maintain his wife and five children. A lady of the name of Longueville made this sealing wax known at court, and persuaded Louis the Thirteenth to use it: after which it was purchased and used throughout all Paris. By this article, Rousseau, before the expiration of a year, gained 50,000 livres. It acquired the name of *Cire d'Espagne*, (Spanish wax,) because at that time a kind of gum lac, which was prepared in an inferior way, was known as *Cire de Portugal*, (Portugal wax).

Sealing wax, however, was used in Europe long before this period, for there is a letter in existence, dated as early as August 3, 1554, which is sealed with this modern species of sealing wax. We have here an instance of the difficulty of fixing the date of inventions or discoveries.

This useful material is made of gum lac, melted and prepared with resin, and coloured with pigments of various hues, of which, however, the prevailing one is red. The hard red sealing wax is made by mixing together two parts of shell lac, one part of resin, and one of vermilion, all in a powdered state. They are then melted over a slow fire, and when they appear thoroughly incorporated, are poured into moulds either ornamental or plain, or else they are rolled out into the form of sticks. In the latter case the soft mass is put on a copper-plate or on a stone, and rolled with a board lined with copper or block tin, to the required length and thickness. The polish or gloss is given to the sticks by exposing them to a fire. For this purpose a furnace or stove is used, somewhat resembling a pail, with bars at the bottom for holding charcoal, and notched at the top of the sides for putting the sticks of wax over the fire. In this manner the sticks are conveniently turned about till the wax is so melted on the surface as to become smooth and shining. Hard sealing wax may be formed into balls, by putting a proper quantity on a plate, and when made into a round form, rolled with the board till it becomes smooth.

Seed lac may be substituted for the shell lac, and instead of resin, boiled Venice turpentine may be employed. There is a coarse kind of sealing wax which may be made by mixing two parts of resin and of shell lac, vermilion and red lead, in the proportion of one vermilion to two of red lead. The vermilion and shell lac are both frequently omitted when cheapness is an object; but the wax thus made is of a very inferior kind.

The best black sealing wax is prepared as above described, except that ivory-black is substituted for the vermilion, and in the commoner kinds, lamp-black.

Coloured sealing wax is prepared in other respects in the same way, only altering the colouring matter according to the tint required. For green wax, instead of vermilion, powdered verdigris is employed: for a brighter green, distilled or crystals of verdigris: for blue, powdered smalt: for light blue, verditer, or a mixture of verditer and smalt: for yellow, masticot; or for a brighter tint, turbith mineral. The purple wax is made like the red, only lessening the quantity of vermilion, and taking a larger or smaller proportion of smalt, according to the required shade of colour.

Most of the cheap sealing wax that is hawked about the streets, is disguised so as to assume the appearance of good wax. The sticks are prepared from the coarsest and cheapest materials, and then covered with a very thin coat of the best sealing wax. This is done by warming the sticks of inferior wax, covering them with the best wax in a state of powder, and then melting this powder by the application of heat.

Such, then, is a short view of the circumstances attending the introduction of sealing wax, or more correctly, sealing resin, and of the mode by which it is prepared.

WHAT IS A COAL-MINE?

A COAL-MINE resembles in some degree a stone-quarry, or a series of stone-quarries, but it is necessary to suppose them to be worked at such a depth as not to be exposed to the day, and therefore requiring pillars of the stone to be left undisturbed, for the purpose of supporting the strata lying above them; through which strata a shaft or pit is sunk into the mine to open it out, to allow the workmen to enter into and depart from it, and to permit its produce to be raised to the surface. It is a scene of great activity, men and horses are kept almost constantly at work; here also are light rail-roads, and trucks, and sometimes steam-engines, for carrying the coal from the place of working to the pit or shaft.

The men work by what are termed "shifts," or a gang, one gang taking the "day-shift," another the "night-shift;" thus the mine is kept at work night and day, excepting on Sundays, pay-days, and holidays. The men "come to bank," or ascend the pit and go to their houses when not at work, and are remarkably cleanly, washing themselves carefully whenever they leave work. The horses are sent to bank only when it is deemed necessary to give them a run out, and this is very seldom; they are provided with good stabling below.

The danger of working in coal-mines is sometimes considerable, and chiefly arises from the inflammable gas contained in the coals, from water collected in old workings, and from the falling of the roof, or stone which is always found above the coal. When fissures occur in the coal, they are generally filled with the gas, and on the fissure being pierced, the gas issues forth into the workings, and if not observed will take fire at the lights of the miners, and explode, producing sometimes most dreadful effects. After the explosion, what the miners call "choke damp" comes on, and those who may have escaped the "blast," or explosion, frequently fall victims to the choke-damp. Some strata, or seams of coal, give out gas from all parts, and are the most dangerous to work in.

To enable the miners to work in such places, they use a lamp covered with fine wire-gauze, called the *safety lamp*, which will burn in the foul air, without causing an explosion until the wire of the lamp becomes red-hot. The lamp serves also to warn the

miner of his danger from foul air, as on coming in contact with it, the flame dilates and changes colour. In places where the air is not so foul, the mine is frequently lighted up with common lamps, and by the men carrying candles. The different shafts of a mine are likewise used for the important purpose of ventilating it. By lighting a large fire at the bottom of one shaft, a quick and powerful upward draft is produced; to supply the vacuum thus created in the mine, a current of fresh and cold air rushes down the other shaft. A circulation of air being thus secured, the fresh air is, by means of trap-doors and other contrivances, conducted into every part of the mine where the men are working, before it is permitted to escape at the "upcast" shaft, or that where the fire is; the other is called a "downcast" shaft.

In digging, the miners meet with many springs, some of which are possessed of strong saline properties. Sometimes the miners pierce strong springs, or old workings, which during many years have been reservoirs for water, when the water rushes into the mine with great force, and drowns the men. The water must then be got out of the mine before the working can proceed. This is done by vast pumps, worked by steam-engines; one stroke of which will raise as much water as five hundred men could pump out. Whilst sinking a pit recently, in the county of Durham, a feeder of water was encountered which required the engines to pump upwards of four thousand gallons in a minute.

Where the roof of the mine is bad, it is supported with timber. Portions, however, sometimes fall before their weakness is discovered by the miners, not unfrequently causing death. Accidents of this kind are, however, from their nature, limited in their fatal consequences; and they sometimes are the occasion of most singular hair-breadth escapes. If the roof fall when the mine is foul, and damage any of the lamps, then there is great risk of an explosion. Some explosions are accounted for in this way.

The depth of "some" of the mines should be stated at "upwards of fifteen hundred feet." One is 1700: 1000 and 1200 feet are now frequent.—Say 170 to 200 fathoms.

THE METEOR.

A SHEPHERD on the silent moor
Pursued his lone employ,
And by him watched, at midnight hour,
His loved and gentle boy.

The night was still, the sky was clear,
The moon and stars were bright;
And well the youngster loved to hear
Of those fair orbs of light.

When lo! an earth-born meteor's glare
Made stars and planets dim;
In transient splendour through the air
Its glory seemed to swim.

No more could star's or planet's spell
The stripling's eye enchant:
He only urged his sire to tell
Of this new visitant.

But ere the shepherd found a tongue,
The meteor's gleam was gone;
And in their glory o'er them hung
The orbs of night alone.

Canst thou the simple lesson read
My artless muse hath given?
The only lights that safely lead
Are those that shine from heaven.

One far more bright than sun or star
Is lit in every soul;
To guide, if nothing earthly mar,
To heaven's eternal goal!—BARTON.

RESISTANCE OF PLANTS TO THE WINDS.

THOUGH the uses of the winds have often been pointed out, I know not who has remarked on that beautiful balance of force and resistance by which the velocity of the atmosphere, or uniting to this the appointed gravity of that body, its momentum, is kept within the bounds necessary to the safe existence of the vegetable world. It must not be said, as it has often been asserted of creation, that this limit of force was contingent on the constitution of the atmosphere and the moving powers; and is therefore a necessity, not the result of design. There are hurricanes, as permitted evils, or appointed variations for special ends; and if they are among the usual exceptions to what we deem a perfect order of things, so do they prove that such forces might occur more frequently, or act perpetually, had it been ordained or permitted. But to have done this would have been to destroy the vegetable races, or else to demand the construction of stronger ones, endued with the necessary resisting power. And in this is seen the balance in question: it is an adaptation made in wisdom, not a chance; while if we compare the apparent feebleness of structure so frequent in plants, with the extent of exposure and the enormous forces to which they are so often subjected without injury, we cannot fail to be interested in the facts, and in the means by which these compensations are effected.

Those facts are open to every one. There is no tree so large, no plant so humble and tender, as not to resist the strongest gales; with exception of those rare excesses which form parts of the appointed destructive powers of creation. The tree is rarely broken, more rarely uprooted; scarcely does it lose the tenderest branch, when bending for days to the blast: and even the leaf, attached by a slender stem, and destined to fall at no distant day, defies the storm while its appointed office is required. The flexible and feeble rose-bush is tormented by the winds as if it would be dispersed in fragments, yet scarcely a petal is displaced till the time approaches when it would have fallen without a touch. It is intended that they should aid in scattering the seeds of plants: yet never perhaps was an unripe one detached by the utmost severity of the gale, tender as its attachment may be, tender as we know it to be in the case of the dandelion. No one, knowing the nature of these parts in plants, and not knowing these facts, could have expected such resistance: it is only the experience of the cultivator which tells him, that neither will his corn-stalk be broken nor its seed dislodged, by aught less than the hurricane or the whirlwind.

All this is effected with the utmost facility, not through strength but through weakness; by yielding, not by resistance. In lieu of that which could not be granted, the parts of plants have been endowed with flexibility and elasticity, in addition to such tenacity as was admissible: they are the corrective and compensating power, and the result shows that the adaptation is perfect; while we cannot doubt the design, when we find that elasticity, one of the most beautiful and mysterious of the laws of matter, intended not only for evading force, but for equalizing and continuing motion, is diffused through the vegetable world, wherever it can serve this purpose, and no where else; effecting the ends in view, here as elsewhere, through the gradual instead of the sudden retardation of communicated motion.

Should a vane be fixed, it would be broken or bent by the storm: it is free to move, and in this motion it finds a shelter from violence. Thus also is a leaf empowered to place itself in a parallel to the stream

of wind, and thence to defeat or elude its force; while the flexibility and elasticity of the foot-stalk enable it to conform to the most capricious and sudden changes; insomuch that there is scarcely an attachment so feeble as to be insufficient for security. To go through even a small part of the variations which occur in different plants under this principle, to show how, under different degrees of strength and of flexibility, and under differences in form and in the modes of resistance and escape, the desired end is always attained, would far exceed these limits: the student of nature may pursue this investigation through the whole range, down to Nasturtium, (Tropæolum,) where the length and flexibility of the foot-stalk still form an effectual remedy, though the principle for the construction of a leaf and its stem is reversed.

If the herbaceous plant is low that it may find shelter, or otherwise evade the winds, the tall tree is protected by some peculiar construction or qualities. The fir tribe is little flexible or elastic, because this would have interfered with the destined purposes of its wood for the uses of man; but, in compensation, its foliage is such that the winds can pervade it more easily than that of any other trees. Under that of the oak it would have been destroyed: while this tree, reversely, opposing to the winds a solid mass of leaves, is strong both in material and form, although little yielding, The no less full ash bends to the blast, through its flexibility, recovering by its elasticity, while its high tenacity constitutes the remainder of its protection. If the Cactus, Agave, and many similar plants, are neither tenacious, nor flexible, nor elastic, they are strong in form and in structure; the latter resembling that contrivance in bones, by which bulk is produced without weight, and strength without mass of materials. In the vine, and in many more plants; in bryony very remarkably, the tendril does not serve merely as a support; since in curling itself far more than is necessary for that purpose, it becomes a spiral spring, allowing the plant to yield to the winds, and restoring it to its place as their force passes away. It is almost superfluous to point out how the delicacy of the foot-stalks in the panicled grasses, added to the elastic flexibility of the whole stem, defends the flowers from any torments the storm can inflict: while interesting variations will be found in Aira, Agrostis, Briza, and many others, with examples of elasticity in many more, not always exceeded by that of our metal springs. And if, in this tribe, the length and flexibility of the filaments afford singular protection to the anthers, independently of the more direct purpose which they serve, in permitting their contact with the surrounding stigmas, so does the anther, almost every where, afford another example of contrivance subservient to this purpose, if to move, in that articulation which so far exceeds the ball-and-socket joint in freedom, that it almost seems as if no attachment existed. One other circumstance may be mentioned; that which, depending on the sensibility of the vegetable organization, is only called into action when it is wanted; being displayed in the increased action of the tendrils, in the further spreading or growth of the roots, and in that general increase of strength which follows from exposure, very remarkably in the outer trees of a forest.

It must suffice to have thus shown, that in this department of life the Divine wisdom has adapted the resisting powers to the injurious forces, through a great diversity of contrivances, and with a success as perfect as the general intention is unquestionable.

[Macculloch's *Proofs and Illustrations of the Attributes of God.*]

ELECTRICITY.

No. VI.

Electrical Experiments.

The electric spark is an object of peculiar interest to all classes of observers, especially to philosophers.

When an electrical machine is in good action, if we bring the knuckle, or a brass ball, near the positive conductor, brilliant sparks, or rather streaks of light, will dart from it; following each other in quick succession, but varying in their colour and form, according to the distance to which they are transmitted. When the spark is received by the knuckle, it is necessary to turn back the cuff of the coat, to prevent the electricity from being conveyed by it from the machine. This precaution is also applicable to other parts of the dress, which should be properly secured whilst conducting all kinds of electrical experiments; for if permitted to get near the apparatus, they will materially interfere with the results.

The best method of investigating electrical light, as it is exhibited when passing through air, is by means of two brass balls, each about two inches in diameter. One of these balls must be fixed to the conductor, at that part farthest from the machine, and the other held in the hand of the operator. The latter ball being placed at what is termed the *striking distance* from the other, and which depends on the size and power of the machine, a spark or flash of white light, tinged at one of its extremities with violet, will pass between them. On gradually separating the balls, the sparks will pass less frequently, and as the distance increases, the violet colour will prevail. If a ball one inch in diameter be substituted for that attached to the conductor, electricity of higher intensity will be obtained, and it will consequently pass through a greater space.

Under these circumstances, and with a twenty-four inch plate machine now before us, the sparks can be made to vary from four to ten inches in length. As their length is increased, they assume a zigzag, and ultimately a forked appearance, exactly resembling lightning; and instead of proceeding direct towards the centre of the large ball (which is held in the hand), they seem attracted by irregularities at various parts of its surface, or probably by particles floating in the atmosphere, but which are too minute to be detected. The colour of these sparks or flashes is fainter in proportion as they are more diffused, changing from violet to deep red.

We have always found the part of the conductor of a plate machine at which the longest sparks can be taken, is at the angle where the piece is returned which carries the steel points. When the machine, to which we just now referred, is in good condition, and the atmosphere favourable, we have no difficulty in obtaining from it, at the part we have mentioned, a rapid succession of sparks, from nine to twelve inches in length. It is also deserving of notice, that the time most favourable for the developement of these sparks or flashes is during the first three or four turns of the machine, immediately after its action has been for a few minutes suspended.

With a cylinder machine the phenomena attending electrical light can be illustrated somewhat differently from the manner we have described; by which we learn that the forms as well as colours of the sparks are determined (other conditions being the same) by the nature of the electricity; whilst they partake of a mixed character when one substance is positively, and the other negatively, electrified.

Nor must we omit to mention that the size, form, colour, and other attributes of the electric spark,

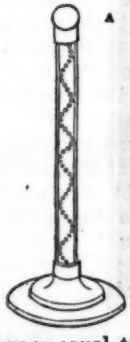
depend on the nature of the substances through which it is transmitted, or upon which it is received; as also on the forms of those substances, and the direction in which the spark enters or leaves them; and whether it merely passes over, or penetrates beneath, their surfaces. Thus, the sparks which pass between the polished surfaces of most of the metals are intensely white; but when communicated by a metal to any part of the human body, their colour inclines to violet. The sparks taken from ivory, box, and some other kinds of wood are red, as they are also from green vegetable substances, from ice, or water, and in some cases from iron. From chalk, and many other minerals, their colour is white, occasionally tinged with yellow; whilst those from loaf-sugar, and gilt or silvered leather, are a beautiful green.

But in many instances these colours are modified by particular circumstances, and by imperceptible gradations become so nicely blended, as to lose all traces of their several peculiarities. This is effected by merely altering the forms, or changing the relative positions, of the substances above enumerated. For instance: if we fix a piece of stout wire (about six inches long, and having a sharp point at one end), upon the conductor, and bring near to it a brass ball, at a certain distance from its point, a rapid discharge of brilliant sparks will ensue; but on slowly withdrawing the ball to a greater distance from the point, the sparks, gradually changing from white to violet, will at length disappear; their place being occupied by detached rays of violet-coloured light. If we now reverse this experiment, fixing the ball on the conductor, and approaching it, at the same distance as before, with the point, there will be only a bright speck or star on the latter; the whole of the electricity excited by the machine being in this case silently and almost imperceptibly withdrawn.

This experiment can be varied in the following manner:—Insert the pointed wire into a piece of glass tube about its own length, and quite smooth at the ends. On presenting one end of the tube, with the point just protruding, to the conductor, and then slowly withdrawing the point, sparks will pass between it and the conductor, within the tube, in the same manner as if a ball were used.

As the influence of points upon bodies charged with electricity will occupy our attention more fully by and by, we shall only remark here, by way of caution, the necessity of avoiding angular and sharp-pointed projections in the preparation of electrical apparatus, the various parts of which, whether of wood, glass, or metal, require to be finished with their surfaces and edges as smooth as possible.

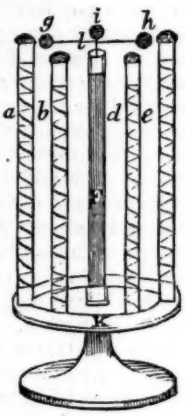
Now let us describe a few, among the many, ingenious contrivances, for exhibiting the electric spark when passing through air, and its effects on various substances which may be placed within its influence.



We begin with the spiral-tube, which is sometimes fitted with a spherical brass cap at each end, and is then intended to be held in the hand, or it can be fixed to a stand, as in the accompanying figure. It is constructed in the following manner:—two glass tubes, one to go within the other, are provided; the smallest being about three-fourths of an inch in diameter, and eighteen inches long, and the other an inch shorter. On the outside of the small tube discs of tin-foil are pasted in a spiral form, a space equal to about the one-fiftieth of an inch being left between them. The smaller tube is made longer than the other, that it may enter the brass cap A, and by means of a piece of tin-foil, be brought into metallic contact with it. The end A being placed at the distance of about an inch from the conductor, on turning the machine a series of beautiful sparks, following each other very rapidly, will pass along the tube, and when the room is darkened will resemble a continuous stream, rather than intermitting coruscations of light.

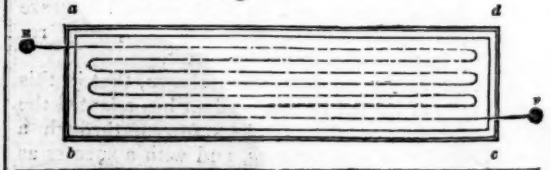
It will of course be understood, that if the discs were in contact, the effect, as described, would not be produced; for electricity is not visible when passing through good conductors; the light, therefore, is occasioned by its forcing a passage across the thin column of air interposed between the edges of the discs.

Here is another piece of apparatus, consisting of five spiral tubes, *a b c* (not seen in the fig.) *d* and *e*, which are arranged around a stand K, on the centre of which is fixed an insulated glass pillar F. At the top of this pillar is a small brass rod, *l*, placed horizontally, to which are attached three brass balls, *g h i*, and underneath the latter ball is a small pivot, on which the rod revolves. The lower extremities of the tubes are in metallic contact, a thin brass ring being let into the stand for that purpose.



The conductor, or, what is more convenient, a jointed arm connected with it, being brought immediately over the ball *i* and the rod *l* set in motion, on working the machine, the rod will revolve with considerable velocity, communicating electricity to each of the tubes in succession, which will exhibit streams of light in a spiral form, and in the dark it will appear as if the tubes themselves were in motion, the illusion being assisted by reflection from the glass pillar in the centre.

Luminous words and figures are also successfully employed in illustrating the properties of electricity. Let *a b c d* be a neat frame of well-seasoned mahogany, containing two plates of glass, of equal size and perfectly flat; on one of the plates narrow strips of tin-foil are pasted, forming an unbroken connexion throughout the seven parallel lines, which extend nearly from end to end of the glass, communicating at one extremity with the brass ball E, and at the other with F. When the paste is dry, the foil is divided by a sharp knife, the separations being so arranged that they may form the word LIGHT, or any other word or device that may be required. The other plate of glass is intended only to protect the tin-foil from dust or accidental disarrangement. The ball E being placed near the conductor, whilst F communicates by a chain with the floor, on passing a succession of sparks through the foil, the word or device delineated on it will appear in luminous characters on the surface of the glass.



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